# Volume 1

# Introduction (GH)

The planet on which we live has significantly changed over the last century. Advances in technology, which started with the industrially revolution, have been cited as the main cause for the exponential growth in population that has been seen since the late 1800s ([Jones 1999](#_ENREF_3)). The success in reducing death rates has been attributed to medical innovations, significant improvements in public sanitation and a development in food production and distribution ([Kinder 2012](#_ENREF_4)). These factors have allowed global population to grow from 2 billion people in 1950 ([Peter Daniels 2008](#_ENREF_6)) to the current population of approximately 7 billion people ([Rahman 2011](#_ENREF_7)).

The industrial revolution that has brought about the strain on the Earth’s resources from an increased population could also be the solution to the same problem. We are in a unique position to use recent innovations in technology to explore and potentially colonize other planets, with the hope to safe-guard the human race for years to come.

In order to further space exploration there has to be a natural progression in technology. The space race culminated in the moon landings in 1969, but it wasn’t until 1998 that the next major the step in space technology was reached with the construction of the first module of the International Space Station (ISS). The next natural progression would be the establishment of a lunar base station, as this would allow long term base station to test technology with the advantage of a having a short distance to return to Earth for safety. However this technology could be tested on the ISS, allowing resources to be allocated to a Mars base station, which would offer the following advantages:

* The gravity on Mars is only one third of that on Earth ([Williams 2010](#_ENREF_9)), with the gravity on the Moon being one sixth of that on Earth ([Williams 2010](#_ENREF_10)). Similar conditions to Earth would assist assimilation of any the crew members.
* The length of a day on Mars is just over 24 hours. This similarity to the length of a day on Earth would encourage the growth of plant life on Mars ([Williams 2010](#_ENREF_9)).
* The Moon has no atmosphere to take advantage of, whereas there are resources that could be harvested on Mars to supplement life support; CO2 in the atmosphere and water in the polar ice caps ([Thomas A. Sullivan 1991](#_ENREF_8)).

The scientific advantages of investing in a Mars base station clearly outweighs those of a lunar base station, so it is understandable that the natural progression in skipped the Lunar base and went straight to the design of a Mars base station.

# Design Brief (GH)

The objectives of a space exploration program that would establish a base station on Mars can be divided into short term objectives and long term objectives.

## Short term objectives

**Life support system for a 10 person crew**

The primary goal is to design a sustainable life support system that can safely, reliably and continuously sustain a crew of 10 people with scheduled resupply being supplied every 18 months. As part of this objective the utilisation of the resources on Mars should be considered in order to reduce the amount of food and water that is required to be sent as part of the payload.

**Act as a platform for space research**

A Mars base station would allow long term research to be conducted, paving the way for human colonization in the future. A recent Russian experiment has tested the psychological effect a mission to Mars, by having a simulated crew in isolation for 18 months ([Amos 2011](#_ENREF_2)). By simply conducting these experiments the intent to explore Mars in the future is clearly demonstrated.

**Kick start a waning industry of space exploration**

A permanent Mars base station would commit the interests of space agencies such as National Aeronautics & Space Agency (NASA) and the European Space Agency (ESA) to develop technology that is suited to the longer periods of travel that will be associated trips to and from Mars. This is the next milestone to be achieved in order to allow further progress space exploration.

**Serve as a launch pad of further space exploration**

When a base station on Mars has been optimised space exploration can look further afield. Preliminary tests suggest that Europa, one of the moons of Jupiter, is a good candidate a next step beyond a Mars base station ([National Research Council 1999](#_ENREF_5)). It has an atmosphere that primarily consists of oxygen and a surface that consists of ice, so could be a source of water for any crew. Development in long distance travel from a Mars mission will make a station of Europa more feasible in the future.

## Long term objectives

In an interview in April 2007 Stephen Hawking is quoted as saying ([age-of-the-sage.org 2007](#_ENREF_1)):

*“I believe that life on Earth is at an ever increasing risk of being wiped out by a disaster such as sudden global warming, nuclear war, a genetically engineered virus, or other dangers. I think the human race has no future if it doesn't go into space. I therefore want to encourage public interest in space.”*

The long term survival of the human race could be dependent on the establishment of inter-planetary colonies. A Mars base station has the potential to develop into a prototype colony, acting as a springboard for colonization into the rest of the solar system, though at this current time the very concept of this seems a lot like science fiction.

## Major constraints of design

As part of this project there are many aspects to consider that will affect the final design, however there are certain constraints that will play a fundamental role in every facet of the design. The main function of these constraints is to ensure that the life support system on the Mars base station is both safe and sustainable.

### Safety

Safety of the crew is paramount when conducting any mission into space. The risks associated with space flight aren’t as acceptable as they were when the space race was first started. The main driving forces in space technology, USA and Russia, are considered to be world superpowers and very affluent. If there were any incidents that would cause the lives of a crew member to be put in danger it be a disaster, causing the development of the space program lose public and political backing and severely hindering any potential for progress.

### Financial Sustainability

In order to make the Mars base station sustainable it has to be financially feasible. The main restriction that would cause the base station to fail is the massive cost of resupply, which is estimated at £1 million per kilogram. Even reducing the resupply that is required in the smallest of way would result in a significant financial saving.

### Reliability

With a resupply shuttle being scheduled every 18 months it is crucial that any units that are critical to life support are reliable and can run for the full duration with only scheduled maintenance. All units must be within this basic, yet crucial parameter.

### Energy Sustainability

With a Nuclear reactor with a capacity of 50 MWe available to power the station the constraint due to power consumption can be marginalised, however energy should not be wasted and any opportunity for energy integration should be taken to make the base station for sustainable.

# References

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